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The Loss of the "Osoaviakhim"

At 9 a.m. on January 30th a Soviet balloon, the Osoaviakhim, with a specially constructed gondola and a crew of three—M. Fedoseenko, M. Vasenko and M. Usyskin, commenced an ascent into the stratosphere and before noon reached a height of 22,000 metres (72,000 feet) the greatest elevation yet obtained. On the following day the sad news was received that the gondola had been torn away from the balloon and had fallen from an unknown height, all three members of the heroic crew being killed.

A Commission of Inquiry immediately left for the spot where the disaster occurred, and the following account of the report of the Commission is translated from the *Moscow Daily News* for February 2nd:—

"The inquiry commission into the disaster reports that the maximum height reached was 22,000 metres (on January 31st, *Izvestia* reported the maximum height was 20,600 metres).

The excessive and progressively increasing velocity of the descent of the stratostat began at 4.10 p.m. at a height of 12,000 metres. This caused the snapping of some of the trusses, and disturbed the equilibrium of the stratostat, causing the severance of the gondola from the balloon. The disaster actually occurred at 4.23 p.m. The biograph worked till 4.21 and the records in the diary were kept up to 4.7. The diary and the biograph

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readings are intact. These show that at 12.33 p.m. the stratostat reached an altitude of 22,000 metres, and remained at that height till 12.45 when the descent was begun.

The commission strongly denounced the theory that the disaster was caused by the stratostat being weighed down by ice. Eye-witnesses caught glimpses of it during the descent. Until 4.10 p.m. the records show that the crew were in the best of spirits and had every hope of a good landing.

Two airmen, Popov and Konavalchik, have informed Oso-aviakhim (Society for Aviation and Chemical Warfare) that they are ready to make another ascent into the stratosphere."

Commemorating the First Stratosphere Balloon Flights

The recognition by the Belgian post office in 1932 of Professor Piccard's two balloon ascents into the stratosphere created one of the rare links, possibly the first, between philately and meteorology. In commemoration of these pioneer feats two large postage stamps were issued inscribed with a design of the balloon and the dates of the flights, one stamp in brown of value 75 centimes and the other blue for 1f. 75c. Piccard's ascents were undertaken in the interests of scientific research, particularly to obtain observation of cosmic radiation in regions removed from the immediate effects of the earth's surface, but once he had demonstrated the practicability of a balloon flight into the stratosphere, it was only to be expected that others should soon endeavour to improve on his height record of over 53,000 feet. This has in fact already been exceeded on three occasions; a balloon released in the United States has reached to over 61,000 feet, and the Union of Soviet Socialist Republics balloons to 62,000 and 72,000 feet approximately. The latter country has followed the example of Belgium in celebrating its success with the issue of a set of three postage stamps, each with a design of the balloon—one for 5 kopecs in blue, for 10 kopecs in red, and for 20 kopecs in violet. Photographs of the Belgian and U.S.S.R. stamps are reproduced as the frontispiece of this number of the magazine. These show the balloon in its elongated state when about to leave the ground. It does not seem to be generally realised by the public that as the balloon ascends and the gas expands, it gradually assumes the customary spherical shape.

Detailed results of these notable ascents have not yet come to hand. The lowest temperature experienced by the first U.S.S.R. balloon is reported to have been 120·6°F. below the freezing point (−67°C.). As the base of the stratosphere is at about 36,000 feet in these latitudes it is seen that just half of the second U.S.S.R. ascent took place within this region. Unfortunately this flight, which was made in January of this year,

ended in tragedy, as described in the preceding pages. Incidentally a height of 72,000 ft. (22 Km.) is about equal to the greatest achieved by unmanned balloons until a year or two ago, but more recently the construction of sounding-balloons has been improved so much that M. Jaumotte in Belgium has been sending balloons on the average up to 27 Km. (88,000 ft.) and a height of 33 Km. (108,000 ft.) has been attained.

At the moment other preparations are being made to further the exploration of the stratosphere. In particular may be noticed Professor J. S. Haldane's invention of a kind of diving suit which will so protect the balloonist that the sealed cabin which has hitherto been used will be unnecessary, and with the saving of weight much greater heights should be attainable. It is clear that the end is not yet in sight.

A. F. Crossley.

A Thermal Anomaly in the Stratosphere

In *Bulletins de l'Academie royale de Belgique* of December 2nd, 1933, pp. 1311-31, M. Jaumotte gives an account of a number of high soundings made with free balloons into the stratosphere from Uccle between April and September, 1933. These soundings were part of a special effort made in connexion with the Polar Year, and for a period of 13 months daily soundings were made. Up till April, 1933, no unusual heights were reached, but at that time a change in the type of balloon employed resulted in a number of the succeeding soundings reaching heights of 25 Km. or more, and these latter revealed a remarkable systematic negative lapse rate within the stratosphere. It was found that all through the summer half of 1933, from a point some kilometres above the tropopause, the temperature rose more or less steadily with height up to the highest point reached, which in two cases exceeded 29 Km. The height at which this conspicuous inversion started appeared to fall steadily, being about 17 Km. above M.S.L. in June and about 14 Km. in September. The mean rise of temperature was about 2·4°C. per Km.; the temperature at the highest point was sometimes over 240°A., the latter occurring at heights which varied between 22 and 32 Km. above M.S.L. Most of the soundings were made by day, but a few made at night agreed in the general features with those made by day.

As is well known, at great heights in the daytime intense solar radiation exists, while the density of the air is very low, hence it is very easy to record temperatures at these levels appreciably higher than the real air temperature; also at a height of 30 Km. the pressure is only about 14 mb., and falls off at the rate of about 2 mb. per Km., unless therefore the

barograph employed is accurate and thoroughly calibrated it is easy to make serious errors in the calculation of the height. M. Jaumotte is well aware of both of these difficulties and has taken pains to overcome them; he lays all his cards on the table, and the reader can judge for himself of the reliability of his figures. In the opinion of the writer there is no reason to doubt the substantial accuracy of the results which he has obtained.

From this point M. Jaumotte becomes more speculative. He puts forward the hypothesis that the reason for this large and unsuspected inversion is the presence of fine volcanic dust originally thrown up into the upper atmosphere by the eruptions in the Corderillas in April, 1932, and slowly sinking ever since. He regards the lower limit of the inversion as indicating the level to which the dust has penetrated downwards, and supports his hypothesis by the aid of various calculations. Whether or not this explanation be finally accepted must depend on the extent to which it is confirmed by other observations, both those made at the same time elsewhere and in the future. Be that as it may, the outstanding results of M. Jaumotte's work are first that he has found it possible to explore the stratosphere systematically to a greater height than has been usual heretofore, and secondly that he has proved that this part of the atmosphere over Belgium in the summer of 1933 was far from being an isothermal region.

One comment may be made; this paper brings out the misfortune of the present almost universal habit of making soundings into the stratosphere during the hours of daylight, when the difficulties besetting the accurate measurement of temperature are at their maximum. The same soundings made at night would have told their tale even more convincingly, without the need of elaborate justification, such as is invariably required when soundings are made by day.

In order to test the probability of the truth of M. Jaumotte's hypothesis, the writer has examined the published data of a number of soundings reaching heights of 24 Km. or more, made from various other stations on the continent of Europe during recent years up to 1930. None of them showed the massive inversion in the stratosphere which M. Jaumotte found in 1933, but on the other hand it is evident that from the height of 14 Km. upwards there is in the summer half of the year a greater tendency towards a systematic rise of temperature with height than there is in the winter half of the year. Soundings made in England have not reached such great heights as those on the continent, but in the 10 years ending January, 1934, some 26 have reached 21 Km., and it is equally clear from them that in England also the tendency towards a steady rise of temperature with height above 14 Km. does definitely appear in the summer half of the year, but that in the winter half it

is absent or very slight. The two highest soundings made in England are particularly interesting. The first was made in September, 1931, and showed exactly the same thing as M. Jaumotte found in 1933, namely a steady rise of temperature from 18 Km. to 25 Km., the highest point. The mean rate was 1·8°C. per Km. and the highest temperature 237°A. This sounding was made in daylight but its credentials were good. The second was made in January, 1934, and reached to between 24 and 25 Km.; no definite rise was found in this case above 14 Km., the temperature at the top being 218°A., which is very close to the mean value at 19 Km. for the time of year.

The inference from both the continental and English soundings is that the inversion found by Jaumotte in the summer of 1933 has not been entirely confined to that year alone, and the possibility is suggested that it may be a seasonal phenomenon which was particularly pronounced in 1933, rather than being entirely due to specific volcanic activity.

In conclusion, a caution may be added against the acceptance, without careful examination, of claims made to have reached heights exceeding 30 Km. with the aid of sounding balloons. This point has been raised before in the *Meteorological Magazine.** The writer has studied the published data of a number of soundings made on the continent of Europe during recent years, and it must be admitted that it is exceedingly difficult to accept some of the claims that have been made. Some of the figures given for the vertical velocities of the ascending balloon in the higher levels are incredibly large, but no hint is given that a slight error in the measurement of the pressure would account for it entirely. Furthermore, some stations publish details of the corrections which have to be applied to the original readings of the pressure in order to allow for the effect of temperature on the recording mechanism. A statistical examination of these corrections shows plainly that very appreciable casual errors must sometimes exist in the computed minimum pressures. It would be a great help if observing stations publishing data of soundings exceeding 30 Km. would discuss the question of the probable error involved in the measurement of pressure at low temperatures with the particular type of instrument which they employ.

L. H. G. Dines.

The Stratosphere

Ever since the discovery of the stratosphere by Teisserenc de Bort at the end of the last century, it has been a problem to meteorologists why the temperature did not continue to decrease

*The highest aerial sounding. Vol. 55, p. 226 and Vol. 56, p. 121.

in that region more or less as it does in the troposphere. It may help to throw light on this question if we ask why the temperature was expected to continue to fall indefinitely. There appear to be three reasons for this expectation:—(1) As the temperature of the base of the atmosphere is that of the surface of the earth, and as the outer limits of the atmosphere must approach the absolute zero of temperature, the air temperature must on the whole decrease from the surface outwards. (2) The temperature is observed to decrease with height up to 10 Km. or more, according to the latitude. (3) There is also a feeling that the temperature should decrease with height because the pressure does.

In regard to (3), the only permanent relevant relations are the gas law $p=R\rho T$, and the dynamical relation $\delta p/\delta z=-g\rho$. From this equation it follows that p must decrease with height, also ρ in general decreases with height; but the distribution of temperature, given by $T=p/R\rho$, remains quite undetermined, and is not settled until some other relationship is introduced, depending, for example, on the relationship between temperature, radiation and convexion. It is true that decreasing pressure together with convexion will result in a decrease of temperature with height, but then convexion is only one factor out of several which are concerned, and in the stratosphere it is almost if not entirely negligible.

The argument based on (2) is solely an extrapolation from observed facts, and cannot be considered to have much merit as the conditions of the stratosphere in regard to convexion and the amount of water-vapour are so different from those of the troposphere.

As to (1), that argument no longer applies, as recent work on the ozone layers has led to the conclusion that the temperature at a height of 50 to 100 Km. is actually higher than at the earth's surface, being in the neighbourhood of 300° to 400° absolute. On this account the temperature must on the whole increase from the tropopause to the first ozone layer, which is centred at about 50 Km. above the surface.

The factors controlling the distribution of temperature therefore change considerably with height. In the troposphere the most important are (i) convexion, (ii) radiation, (iii) latent heat released by condensation of water-vapour, (iv) the transfer of heat horizontally by wind and convexion. In the stratosphere (iii) is zero, (i) and probably (iv) unimportant, and (ii) less potent than at lower levels; while at still greater heights the ozone is of paramount importance. The stratosphere appears to be an inactive region (as regards heat) in which nothing much happens. The isothermal condition, which has been observed only over a few kilometres, and sometimes even then shows a

slight increase of temperature with height, may be regarded as just a rather flat bend in the temperature-height curve, as the gradient changes slowly from negative to positive.

A. F. CROSSLEY.

Ballooning

It is opportune to recall the outstanding ballon ascents made for the furtherance of meteorology by Dr. J. Glaisher, F.R.S., and others which take their place in the story of aerial exploration, beginning with the early efforts of the brothers Montgolfier with their hot-air balloons in 1783, and culminating in the recent ascents to the stratosphere made by Belgian professors and the scientists of the U.S.S.R.

Dr. Glaisher's name is probably most widely known to-day owing to the utility of his hygrometrical tables. But we are reminded by a paragraph in the *Sussex County Magazine* that there is a tablet in the church at East Blatchington, Seaford, commemorating the fact that in September, 1862, Henry Tracey Coxwell " reached an altitude of seven miles, the greatest height ever attained by man." Now this historic ascent of September 5th, 1862, was one of a series of 28 ascents made in the years 1862-6 in which Mr. Glaisher was the observer and Mr. Coxwell the " aeronaut." The events and enterprise which led up to these ascents are worth recounting:

In April, 1837, a letter appeared in the *Morning Advertiser* over the signature of Charles Green, aeronaut, discussing the difficulties of attaining a height of 10 miles owing to the expansion of the gas in the balloon; he had found that the reading of his barometer fell to half its value at 3½ miles up and the gas had of course expanded to about double its size. The discussion was provoked by statements of other writers that if Mr. Green would *inflate fully* the great Vauxhall balloon with pure hydrogen " it might be made to attain an elevation of fifteen miles; or, in other words, about three times the altitude of the highest mountain in the world." Mr. Green estimated that on reaching 10 miles the gas would have expanded to six times its original volume, and as the 70,000 cubic feet required to fill the balloon at ground level cost £240 it would be obviously economical to start with the balloon only one-sixth filled. But the " lift " then available would be insufficient to take up one man. For comparison it should be remembered that the capacity of the Soviet stratostat was 859,700 cubic feet, and the envelope was filled only one-tenth of its capacity at the ground so that it would be fully expanded at about 10½ miles. At the record height of 12 miles it was practically a perfect sphere, although at the start its shape was anything but spherical.

In the first ascent with their *Nassau* balloon in September,

1838, Mr. Green and two others reached 19,335 feet, and were so encouraged that they decided to make a second attempt with two passengers instead of three. This time, starting from Vauxhall with the barometer at 30·5 in. and temperature 61°F., they reached 27,146 feet, and at this height the barometer was 11 in. and the temperature 5°F. Mr. Green had made a number of balloon ascents commencing in 1824, and so frequently found a wind between N. and W. at about 10,000 feet that he contemplated crossing the Atlantic from the American shore!

In 1852 Mr. John Welsh of Kew Observatory made four ascents with Mr. Green in the great *Nassau* balloon, and reached heights of 19,500, 19,100, 12,640 and 22,930 feet. Illness prevented Mr. Welsh from continuing the work.

In 1861 a Committee of the British Association, including Mr. Glaisher, considered the decrease of temperature with altitude and arranged with Mr. Green for the use of his balloon. Mr. Glaisher instructed two observers in the particular work but the arrangements fell through. The Committee then approached Mr. Coxwell, who generously undertook to construct at his own cost a new balloon of greater capacity to attain the high ascents they desired. Thus the *Mammoth* balloon was made of 93,000 cubic feet capacity compared with the 70,000 cubic feet of the *Nassau*. A large and comprehensive programme was drawn up and Mr. Glaisher got together a collection of instruments to determine the temperature of the air and its hygrometrical state up to the greatest heights possible. The cost of each special ascent with Mr. Glaisher and Mr. Coxwell as the only occupants was about £50. Out of the 28 ascents made under these arrangements the highest reached 37,300 feet and six exceeded 20,000 feet. The balloon was usually in the air for two hours.

The following details illustrate the work done:

	Ascent.	Greatest Altitude.		Temperature.	
Date.	*Time.*	*Place.*	*Feet.*	*Start.*	*Lowest.*
1862.				°F.	°F.
17 July	9·43	Wolverhampton	26,177	59·0	16·0
18 Aug.	13·02	,,	23,377	67·8	19·0
21 Aug.	4·30	Mill Hill	14,355	60·8	19·3
5 Sept.	13·03	Wolverhampton	37,300	59·5	5·0
1863					
31 Mar.	16·16	Crystal Palace	22,884	49·2	1·0
18 April	13·16	,, ,,	24,163	61·5	11·5
26 June	13·03	Wolverton	23,200	66·0	17·0
29 Sept.	7·43	Wolverhampton	16,590	48·0	0·0
1864					
29 Aug.	16·06	Crystal Palace	14,581	72·5	28·5

During the ascent on September 5th, 1862, Dr. Glaisher was rendered insensible and Mr. Coxwell's hands were frozen so that he was only able to open the valve by tugging the rope with his teeth.

When the balloon was in cloud at 4 miles high, a railway train

was heard, but with clouds far below nothing was heard; the barking of a dog was audible at 2 miles.

While these observers were exposed in an open basket to the rigour of the atmospheric changes shown above, the Soviet adventurers of 71 years later travelled in an enclosed gondola whose shell was composed of 12 sheets of an aluminium alloy 2 mm. thick. At the highest point of the Soviet ascent on September 30th, 1933, when the atmospheric pressure had fallen to about 68 mb. at nearly 12 miles above the ground, and the temperature to $-90°F.$, the temperature inside the gondola had risen to above $+70°F.$

Dr. Glaisher found that his pulse increased from 76 before starting to 100 at 20,000 feet, and 110 at higher elevations; he became insensible at 29,000 feet. The latter figure is a normal value. It would be expected, however, that the pulse, which is usually about 70 near sea level, would be doubled at 18,000 feet, where the barometric pressure is halved; from observation on people on the Plateau of Pamir at 15,600 feet, pulse-rates between 110 and 124 were found and these may be compared with 68 to 76 at sea level.

R. M. Poulter.

Royal Meteorological Society

The Symons Memorial Lecture of the Royal Meteorological Society will be given this year on March 21st by Mr. J. M. Stagg, M.A., Leader of the British Expedition which occupied Fort Rae in Canada during the Second International Polar Year, 1932-3. The site of Fort Rae is of exceptional interest, as it lies near the zone of maximum frequency of aurora, and auroral photography was one of the most important objects of the expedition. Extensive studies were also made in meteorology, including upper air investigation, atmospheric electricity and terrestrial magnetism. The expedition occupied a site very near to that of the Canadian and British expedition during the first International Polar Year of 1882-3, and this gave an opportunity for obtaining valuable determinations of secular change of the magnetic elements. Mr. Stagg will also describe some of the practical difficulties and interesting or unusual experiences which the expedition met with. As the lecture this year is of unusual interest, the Council has obtained the use of the hall of the Royal Geographical Society, Kensington Gore, which accommodates an audience of 800. The lecture will begin at 7.30 p.m., and the Chair will be taken by Lt.-Col. E. Gold, D.S.O., F.R.S., President of the Royal Meteorological Society.

An additional meeting of the Royal Meteorological Society will be held on March 28th, at 5.30 p.m., at 49, Cromwell Road, South Kensington, when Prof. W. Schmidt, Director of the

Central Meteorological Institute, Vienna, will deliver a lecture on Micro-climatological work in Austria.

The monthly meeting of the Society was held on Wednesday, February 21st, at 49 Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President, in the Chair.

Chang-Wang Tu, M.Sc.—China Rainfall and World-Weather. (Memoirs, Vol. IV, No. 38.)

The objects of this investigation were to discover the relationship between the rainfall of China in the rainy season and world weather; and to find some regression formulæ for foreshadowing China rainfall in the rainy season. Sir Gilbert Walker's shorter method has been used for the calculation of the correlation coefficients and his criteria have been applied for testing the reliability of the coefficients. Four fairly homogeneous regions have been chosen and the rainfall of each region is correlated with the pressure, temperature and rainfall of different seasons at various important stations of the world. It is found that increased circulation of the Southern Oscillation is generally responsible for heavy rainfall during the rainy season in China. The total correlation coefficients obtained from the equations for the North China Coast, Yangtze Delta, Yangtze Valley and south-east China Coast are respectively 0·78, 0·62, 0·68 and 0·68.

C. E. P. Brooks, D.Sc.—The Variation of the Annual Frequency of Thunderstorms in Relation to Sunspots.

A possible relation between thunderstorm frequency and variations of solar activity is of considerable interest, and the author set out to determine statistically whether such a relation exists. Annual frequencies of thunderstorms were formed for 22 groups of stations in all parts of the world over periods up to 66 years and were compared with the annual sunspot numbers. It was found that when sunspots are numerous thunderstorms are more frequent than usual in high northern latitudes and in the tropics, but in temperate latitudes the relation, if any, is small. The $11\frac{1}{2}$ year "thunderstorm cycle" was then compared with the sunspot cycle, and the two were found to run parallel in Sweden and Siberia, but in maritime tropical areas the thunderstorm cycle lags about five months behind the sunspot cycle. Over the earth as a whole the frequency of thunderstorms at sunspot maximum averages about 22 per cent. greater than the frequency at sunspot minimum.

Correspondence

To the Editor, *The Meteorological Magazine.*

In Lighter Vein

Many inquiries have been made as to the cause of the abnormal

drought? and various tentative suggestions have been put forward to explain it. One school attributes it to a change in the volume of the Gulf Stream drift: another suggests that radio-broadcasting has used up most of the ions previously available as nuclei of condensation.

A more plausible reason has recently come to my notice. It is well known that rain in England is mainly derived from evaporation from the Atlantic Ocean; and further that evaporation from spray is much more effective than evaporation from a water surface. A most effective producer of spray is a spouting whale: but there has been so great a reduction in the number of whales in the North Atlantic that this source of rainfall has been nearly cut off—hence the drought.

E. GOLD.

An Unusual Glazed Frost

A curious example of glazed frost occurred here on the morning of February 24th last. During the previous night there had been continuous thick fog (visibility 25-55 yds.) accompanied by heavy rime; the minimum temperature in the screen was 26·9°F., and on the grass 24·3°F. When the regular observations were taken at 9h. a fine drizzle had just set in, and slight glazed frost was beginning to form. The dry bulb then read 29·5°F., and the grass thermometer 31·0°F., while the subsoil temperatures were, at 4 ft. 39·5°F., at 1 ft. 35·5°F., at 6 in. 34·3°F., and at 1 in. 33·0°F. Weather, slight drizzle with persistent thick fog (visibility 55 yds.), wind, S., force 1; relative humidity, 93 per cent. During the next hour it was noticed that the rime was slowly disappearing, from the ground upwards. A special series of observations made at 10h. gave the following readings: dry bulb, 30·8°F.; grass thermometer, 34·3°F.; earth thermometers, at 4 ft. 39·5°F., at 1 ft. 35·9°F., at 6 in. 34·7°F., at 1 in. 34·2°F. Weather, continuous drizzle with persistent thick fog (visibility 55 yds.), wind, SSW., force 1; relative humidity, 94 per cent. By this time the ground and all objects within about 2 ft. of it were quite wet with the drizzle, which had been falling steadily since 9h.; above that level everything was still coated with ice, in the one form or the other. The line below which the rime had melted was remarkably well defined, and with their curtailed mantles of white the trees, bushes and wire fences at the bottom of the valley presented a most striking appearance.

There seemed to be little change in the phenomenon until shortly after 11h., when the screen temperature rose above the freezing point, and both rime and glazed frost quickly vanished. At 11h. 10m. the thermometer on the grass still read 2·1°F. higher than the dry bulb. Weather, cloudy, moderate fog (visi-

bility 550 yds.); wind. SSW., force 2; relative humidity, 91 per cent. The thaw then progressed normally.

It is supposed that the cessation of outward radiation when the sky grew overcast in the early morning was followed by gradual conduction of warmth from the subsoil (sand and gravel over chalk) to the layer of air next the ground, and that the effect of this process extended in the course of a few hours to an elevation of about 2 ft.

The incidence of drizzle and the evidence of the 7h. synoptic chart combine in suggesting that a marked temperature inversion existed higher up, so that here, it seems, was an instance of an apparently stable layer of cold air sandwiched between warmer layers vertically above and below it.

E. L. HAWKE.

Caenwood, Rickmansworth, Herts. March 1st, 1934.

Travel of Thunderstorms

Referring to the article in your February number by R. C. Sutcliffe on the above subject, I have noticed that storms travelling in a north-east direction, which is frequently the case, usually seem to pass on our south-east and sometimes on our north-west.

If they are travelling from south or south-east to north or north-west, we usually get one overhead. I attribute this to the configuration of the high land which lies north and east of us, The Roaches, Buxton, Peak District, and Weavers.

M. A. BOLTON.

Oakamoor, North Staffordshire. February 21st, 1934.

In the February number of the magazine Mr. Sutcliffe raises the question of the influence of topographical features on the movements of thunderstorms and quotes three examples of local belief that the rivers have a controlling influence. There is no doubt that such beliefs are widely held. In the British Rainfall Organization we have very frequently been assured by observers that an apparently low total of rainfall at their station is accounted for by a tendency for thunderstorms to avoid their locality. In some cases the observer adds the further information that the storms tend to follow some definite track such as the line of a river valley.

Like Mr. Sutcliffe I have always found it difficult to accept these statements but I have also felt that it would be a very difficult matter to prove or disprove them. One could say quite positively that the type of thunderstorm associated with the passage of a cold front would take no notice of minor topographical features, but I am doubtful if one could be so definite in regard to the slow-moving storms which occur in what the

French call a *marais barométrique*. We are concerned not so much with the narrow river itself as with the valley drained by the river, and the valley may be many miles wide. It is now, I believe, generally admitted that the formation of clouds of the lenticular variety, which occur at heights comparable with the height of the summit of well-developed cumulo-nimbus, is related to the ground contours. If that be the case we have evidence to show that the ground contours may affect the movement of the air at heights many times greater than the height of the surface irregularities.

On the other hand the evidence afforded by rainfall maps of thunderstorms is conflicting. In some (*e.g.*, the thunderstorm of June 14th, 1914, studied by Mr. J. Fairgrieve*) there does seem to be a tendency for the rain-field to lie along the river valley; in others (*e.g.*, the thunderstorm of May 31st, 1911, also studied by Mr. Fairgrieve†) there is no such tendency.

This is a question the answer to which might be obtained from an intensive study of the data now being accumulated by Mr. S. Morris Bower.

E. G. Bilham.

Dr. Sutcliffe's remarks on this subject in the February issue remind me that while living at Bedford I found prevalent a belief that thunderstorms have a preference for travelling along the low ridges of hills which rise at some three to eight miles' distance to a height of two or three hundred feet above the river valley. It is said that bad storms rarely if ever pass over the town itself. The river Ouse passes through the centre of the town, but I have not heard it mentioned in connexion with thunderstorms. I was unable either to verify or disprove this belief during the three years in which I was stationed at Cardington. It is interesting to observe that the alleged movement is not in disagreement with that mentioned by Dr. Sutcliffe for other towns, and the explanation may be the same. It is possible, however, that there is some truth in the belief at Bedford, as the hills might be effective in initiating or localising convection. On the other hand the area of a storm is generally large enough to allow of ample latitude in the placing of its "centre" by unpractised or prejudiced observers. I might remark also on the curious habit some people indulge in when they experience a slight weather phenomenon (such as a threatening sky or slight thunder) of assuming that "someone's getting it very badly." Thus at Bedford a slight storm over the town can easily be projected in the imagination into a severe storm over the neighbouring hills.

A. F. Crossley.

**British Rainfall*, 1914, pp. 48-56.
†*British Rainfall*, 1911, pp. 26-39.

Whenever a thunderstorm occurred at Felixstowe during my sojourn there I wondered if the residents of Walton-on-Naze or elsewhere, according to the direction of drift of the storm, were referring to their own comparative immunity and the influence of the river Stour or Deben. The map on page 21 of " Summer Thunderstorms " will illustrate the opportunities one is afforded in this respect. Incidentally this same map prompts me to ask if the people of Norwich appreciate the distinction of being specially favoured by the visitation of thunderstorms during that particular period, if not generally.

Traditions that thunderstorms are specially associated with the configuration of the country in the vicinity of the district are cherished by local observers and occasionally appear in the public press. The author of *Geophysical Memoir* No. 24 writes: " considerations of relief, of soil and vegetation, and of geological structure, all combine to give one locality an excess above, and another neighbouring locality a deficit below, the general average of the district." In this particular case it seems more appropriate to me to quote Sir Napier Shaw: " Nature is not at all unwilling to suggest things that turn out not to be true."* He also warns the student of weather not to believe all that he thinks he sees.

I think Mr. Sutcliffe has over-estimated the limit at which storms become noticeable. To verify my own impression a number of publications were examined and the following result obtained; in favourable circumstances thunder can be heard for a distance of twelve to fifteen miles, there are isolated cases of thunder being audible over a distance of thirty-six miles. A mass of thundercloud can be seen for a distance of sixty miles or more but I do not think the ordinary observer associates the cloud with a thunderstorm until he hears the thunder.

J. S. Smith.

Corona, Highview Road, Farnborough, Hants. *February 26th*, 1934.

Dr. Sutcliffe's letter in your February issue under the above heading raises an interesting point. The suggested influence of rivers in controlling storm travel has been reported from several parts of the country, but more particularly from East Anglia.

The storm travel maps for England, which have been prepared from the summer data for 1931 and 1932, appear to confirm the reputed facts that the direction of the river coincides with that of storm travel near Lowestoft and at Wellingborough. There is, however, nothing whatever to suggest that the river is the cause of the coincidence. Storms are sometimes reported to habitually follow a railway, and reasons are added for the control of the railway, but the most that one can assume from such records is that the direction of the railway and that of

*" The Drama of Weather," page 13.

the general drift of storms approximately coincide in the particular district. Nevertheless it is a useful piece of information. At Felixstowe the general direction appears to be more at right angles to the coast, but there are frequently local deviations when a coast line is much indented.

The maps suggest the deflection of storms where relief is marked, but the effect of the hills is probably an indirect one. The reputation of a locality to miss storms is quite frequently reported. Sometimes it is real, but more often it is mainly due to a combination of circumstances such as—distribution of population, visibility, the difficulty of knowing how the rest of the storm is situated with regard to the portion one is observing, etc. These are points which only the co-ordination of triangulated observations over large areas can hope to elucidate.

S. MORRIS BOWER.

Langley Terrace, Oakes, Huddersfield. March 1st, 1934.

Travel of Thunderstorms and Effects of Lightning

During nine years, from 1910 to 1919, when I lived at Althorpe Rectory, on the bank of the Trent in north Lincolnshire, there a broad tidal river, flowing directly from south to north, I formed the conclusion that thunderstorms, which were frequent, undoubtedly tended to follow the course of the river. Never elsewhere have I so frequently experienced alarmingly close lightning. During my residence there, two houses in Althorpe, and one in the neighbouring village of Keadby, were struck by lightning, in each case close to the river bank, though, strange to say, the church, a large conspicuous building of the 15th century, also on the river bank, with a tower 80 feet high, the roof covered with sheet lead and three large bells in the tower, has never in living memory been touched by lightning, although devoid of any conductor. One of the houses struck in Althorpe was a low barn quite close to the church.

In the case of the house at Keadby the details were so extraordinary as to be worth recording. The flash struck a disused chimney, and deviated to the head of an iron bedstead in an upper room, upon which two boys were lying, followed the iron frame underneath the bed, setting the bedding on fire, but without injuring the occupants, descended the further leg of the bedstead, making a hole in the floor into which one's finger could be inserted, and penetrating to the room below. There it travelled straight downwards in the corner until half-way to the floor, when it turned sharply at right angles and passed horizontally along the wall to the next corner, making a blackened score in the wall paper. Again it pierced a hole, big enough to put a finger into, through the wall into a larder behind, fused together some cake tins which lay on a shelf, fitted one inside

the other, and then it passed through the open door of the larder, across the kitchen, and out through the open entrance door of the cottage. In the kitchen four persons were seated round a square table at supper. The flash passed across the table and burned to a blackened cinder a piece of ham which was on a dish in the centre, and on which lay the carving knife and fork, again without injuring any of the four persons. I could not have believed these details true if I had not personally examined the house and the various objects mentioned, and questioned the inhabitants just after the storm. I collected the sum of £5 to replace the bedding and other articles belonging to these poor people, which were destroyed by the lightning, and the block of fused cake tins I presented to the Lincoln Museum.

ALLAN ELLISON.

Washfield Rectory, Tiverton, Devon. February 26th, 1934.

NOTES AND QUERIES

80th Birthday of Sir Napier Shaw

On March 4th Sir Napier Shaw, F.R.S., Director of the Meteorological Office from 1905 until 1920, celebrated his 80th birthday. The following letter was sent to Sir Napier by the Staff Council of the Meteorological Office :—

Dear Sir Napier,

May we offer you on behalf of the staff of the Meteorological Office, and in particular on behalf of those who served under you in the Office and its Observatories, our best wishes on the anniversary which you celebrate on Sunday, 4th March, 1934?

We assure you that you are in the thoughts of many of us on the occasion of your eightieth birthday and we trust that you will enjoy good health during the coming years.

Yours sincerely,

C. E. P. Brooks,
Chairman.

R. M. Poulter,
Secretary.

An account of Sir Napier's work as Director appeared in the *Meteorological Magazine* for September, 1920, p. 161, and the issue for July, 1921, contained a reproduction of his portrait, which was presented by the Staff and a copy of which hangs in the Library of the Meteorological Office.

The Storm Glass and Weather

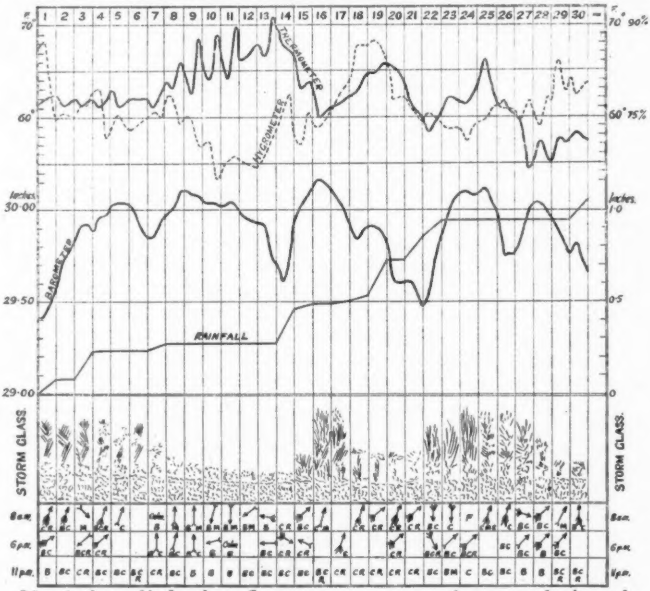
The reference to the storm glass by Mr. E. L. Hawke in his review of Sir Napier Shaw's beautiful book, "The Drama of Weather," recalls to my mind a series of observations of this

instrument made by my father in the year 1891. Since copies of the crystal patterns formed in this curious instrument are seldom seen, the attached chart for the month of September may be of interest. The chart shows clearly the form of crystallisation observed from day to day, together with the associated curves of pressure, temperature, humidity and rainfall, the direction and force of the wind and the state of the sky.

The barometer used was a type of sympiezometer and this instrument, the rain gauge, hair hygrometer and storm glass were all made by my father in his home workshop.

WALTHAM CROSS.

METEOROLOGICAL CHART FOR THE MONTH OF SEPTEMBER 1891.



My father died when I was seven years of age and since he left no drawings or other data, I have no details of construction or exposure of the other instruments, but still have in my possession the sympiezometer and attached storm glass which have, however, not functioned for many years.

The storm glass consisted of a solution of camphor, nitre and sal-ammoniac in absolute alcohol, contained in a glass test-tube, the orifice of which was sealed with a cork and sealing wax. The sympiezometer and storm glass were hung on a wall, in-

doors, in such a way that they were exposed to little change of temperature and free from direct sunlight.

The storm glass seems to have been most active during high winds from the SW. quadrant, with both positive and negative changes of pressure; and more quiescent with a steady barometer. Changes of temperature and humidity seem to have had little effect on the instrument.

DONALD L. CHAMPION.

The Largest Thermometer in the World

We learn from *The Observer* that an enormous illuminated thermometer has been placed on the Eiffel Tower to display the night temperature of Paris. A year ago the enormous face and moving hands of a clock outlined in light were set up on the tower, where they were visible from a large part of Paris. The new thermometer is placed above the clock and extends to the top of the tower. It is graduated from $-10°C.$ to $+20°C.$ (14° to 68°F.).

Rainfall Record at Mogador, Morocco

With the closing of the British Vice-Consulate at Mogador, Morocco, a rainfall rcord which has been maintained for nearly thirty years comes to an end. The observations commenced in September, 1903, and ended with May, 1933, but there have been short gaps totalling 47 months. Mogador lies on the west coast, in 31½°N., in the dry region under the influence of the NE. trade winds, and the average annual rainfall from 1903 to 1933 was only 13·09 in. The monthly averages in inches and the average number of rain-days are as follows:—

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall											
1·56	1·92	2·30	0·94	0·35	0·15	0·00	0·02	0·29	1·15	2·94	1·50
Rain-days											
3·7	5·1	5·6	3·7	2·0	0·4	0·0	0·1	0·8	3·5	6·0	4·4

The double maximum in November and March is interesting: in winter the effect of the anticyclone over the Sahara introduces a minor dry period. The wettest complete year was 1919 with 19·50 in., but in 1912 the total for January, February and September to December was 19·57 in., the observations for March to August being missing. The driest year was 1910 with only 3·56 in. The wettest month was March, 1923, with 10·56 in.—a large fraction of the average annual fall. July was rainless throughout, August was rainless in 21 years out of 23, and June was rainless in 19 years out of 23, but experienced an abnormal total of 1·97 in. on four days in 1930. All months were rainless at least once.

As would be expected, the number of rain-days is small, the

annual average being only 35. Falls of 0·5 in. or more in a day have occurred in every month except July and August, the two heaviest being 8·27 in. on March 31st, 1923, and 5·20 in. on November 14th, 1919, the latter being followed by 3·00 in. on the 15th. These remarkable downpours are typical of the rare and violent storms which occur at long intervals in dry climates.

Reviews

The Climate of the Netherlands. A (continued). Precipitation. First part. By Dr. C. Braak, K. Ned. Meteor. Inst. No. 102. Med. en Verh. 34a. Pp. 76 (Dutch) + 24 (English Summary). Illus. 's Gravenhage, 1933.

This publication supersedes volume No. 15 published in 1913, which deals with rainfall records in Holland up to 1910. There are twenty-three pages of text in English, while the fuller information given in the Dutch text can be readily followed, the headings of the tables being invariably also given in English. Monthly and annual normals are given for 143 stations. In each case the values are based on the period of observation 1891 to 1930.

The distribution of the monthly seasonal and annual amounts is shown in a series of maps on a scale of about 48 miles to 1 inch (1 to 3 million). The annual averages vary little over Holland. The driest station is said to be Kampen, on the east coast of the Zuider Zee, with 597 mm. (23·5 in.), but it is noted that in the table three stations near Roermond in the south-east give weighted normals of 587, 590 and 591 mm. The wettest station is Naals, on the high ground in the extreme south near Aix-la-Chapelle, with 863 mm. (34 in.).

The records at the island stations and along the low-lying west coast of Holland are of interest in defining, in conjunction with similar observations along the east coast of Great Britain and at the Danish Lightships, the probable rainfall over the North Sea. The rainfall in the islands to the north of the Zuider Zee is about 700 mm. (27·6 in.) and further south about 600 mm. (23·6 in.). The rainfall along the east coast between the Humber and the Thames Estuary, on the other side of the north sea, varies from about 23 to 20 in.

Difficulties have been encountered in determining the duration of rainfall, owing to uncertainties during light rain, and Köppen's *Stichproben* method is preferred. In this method the number of hours of rain are deduced from the number of records of rain made at the fixed hours of observation. Mr. Bilham discussed this method in the *Journal of the Royal Meteorological Society*, 1932, p. 38.

It is a little disconcerting to find on p. 82 details of the number of " 'cloudbursts' with at least 0·2 mm. a minute and 4 mm. an hour," but this is obviously a slip in translation (which

occurs elsewhere in the text) for "showers." The question of the frequency of showers is dealt with in a thorough manner, the records being examined from self-recording gauges for four stations covering altogether 84 years. The details given include those for each shower, as defined above, of the greatest mean intensity during periods of 1-5, 6-10, 11-15 minutes, and so on, and of heavy showers with at least 1 mm. a minute. Of the 93 heavy showers on record, 73, or more than three-quarters, occurred during June, July and August.

Details are given of the general rainfall over Holland for each year back to 1849, and the decadal means are compared below with those for England :—

	1850-9	1860-9	1870-9	1880-9	1890-9	1900-9	1910-9	1920-9
England	95	101	108	103	96	98	107	106
Holland	92	98	104	100	97	100	108	100

The values for England are percentages of the mean for the period 1881 to 1915 and for Holland 1849 to 1930. In the case of the decade 1920-9 it is of interest to note that the excesses occurred mainly in the west, while the rainfall along the east of Great Britain was about the normal and therefore similar to that of Holland.

Many other points of equal interest are dealt with in this publication, which discusses the rainfall of a neighbouring country from many aspects. J. GLASSPOOLE.

The Place of Oberation in Astronomy. An inaugural lecture delivered on April 28th, 1933, by H. H. Plaskett. Size 9 × 6 in., pp. 32. Oxford : Clarendon Press, 1933. Price 2s. net ; and

The Composition of the Stars, being the Halley Lecture delivered on June 1st, 1933, by H. N. Russell. Size 9 × 6 in., pp. 31. Oxford : Clarendon Press, 1933. Price 2s. net.

Although these two lectures deal solely with astronomy, they are not without interest to meteorologists. This applies especially to the lecture by Professor Plaskett, in which he traces through the history of astronomy the achievements of observation and theory. They have advanced together, hand in hand, but not abreast, for now one leads, now the other. The most famous example of the leadership of theory is the prediction by Adams and Leverrier of the existence of the planet Neptune, which was subsequently found in the predicted position. This is described as an achievement unique in the annals of science; meteorologists might have rivalled it if they could have predicted the discovery of the stratosphere, but here observation led, though perhaps only by a short length.

Observations are divided into "passive" and "active." Passive observation is the observation of a phenomenon merely

because it is observable; active observation is the observation of a phenomenon because it enables a question to be put or a difficulty cleared up. As a science advances observation becomes almost entirely active; astronomy has reached this stage, but it is to be feared that much meteorological observation is still passive.

The second paper, on the composition of the stars, is more technical—and also more astounding. The word is used advisedly, for the discovery of so much reasoned information about the internal constitution of bodies, the distance of which can only be measured in light years, is an astounding feat of human intelligence. There are many gaps, it is true, but the limitations to which these are due are mostly natural, such as the earth's atmosphere, which interposes an impenetrable barrier of ozone to the shorter wave-lengths in the ultra-violet.

Books Received

Ergebnisse Aerologischer Beobachtungen, 1931. K. Ned. Meteor. Inst. (No. 106 A). Utrecht, 1932.

Scouting for a site for a solar-radiation station, by A. F. Moore. (Smiths. Misc. Coll., Vol. 89, No. 4). Washington, 1933.

Obituary

Mr. C. A. Bracey.—We regret to record the death on February 15th of Mr. Bracey, at the age of 67, after a long and painful illness, borne with great fortitude and patience. The funeral took place at Hemel Hempstead cemetery on the 21st and was attended by Mr. E. G. Bilham, B.Sc., Superintendent of the British Climatology Division (representing the Director of the Meteorological Office), and by several of Mr. Bracey's old colleagues.

Mr. Bracey retired from the Office in November, 1931, after just over 50 years' service, mainly in the British Climatology Division. He prepared a list of the greatest daily falls at some 116 stations in the British Isles from the date of their commencement up to 1915, which are preserved in two volumes in the library of the Office. He also compiled a detailed summary of the daily rainfall observations at Brixton from 1871-1910.

After his retirement he left Apsley End where he had lived for many years and went to reside near Bristol. The climate and quietness of the country did not suit his energetic spirit, and he returned to Apsley again in the summer of 1933 with a view to taking part in the civic life of Hemel Hempstead once more (in his early years there, he had served on the local council), but the fatal illness had already seized upon him and he took to his bed in September of that year.

We regret to learn of the death on December 29th, 1933, at the age of 73, of Baron Alphonse Berget, professor of physical oceanography in the Institut Océanographique, Paris, who published many works on physics and meteorology.

News in Brief

We learn that Mr. D. Brunt, M.A., B.Sc., Superintendent since 1919 of the Army Services Division of the Meteorological Office, has been appointed to the University Chair of Meteorology (Imperial College—Royal College of Science) from October 1st, 1934.

Dr. J. Keränen was appointed Director of the Meteorological Office of Finland by the President of the Republic on November 10th, 1933.

We learn that Mr. Willis Ray Gregg has been appointed Chief of the United States Weather Bureau as from January 31st, 1934, in place of Dr. C. F. Marvin, who is retiring.

The Weather of February, 1934

Pressure was below normal over San Francisco, Alaska, northwest Canada, northern Greenland, Jan Mayen, Spitsbergen, northern Norway, northern Sweden, Russia and Madeira, the greatest deficits being 9·4 mb. at Barrow and 14·1 mb. at Waigatz. Pressure was above normal over most of the United States and Canada, the North Atlantic, south Greenland, Iceland, western, central and south-eastern Europe and the Mediterranean, the greatest excesses being 17·2 mb. at the Scilly Isles and 5·8 mb. at 50° N. 120° W. Temperature was above normal at Spitsbergen and in north Europe and below normal in central and southern Europe, while rainfall was deficient at Spitsbergen and in excess in northern Norway and Sweden (except Gothaland).

February, 1934, in the British Isles was sunny and dry with much mist or fog in south-east England and the Midlands. Many places experienced between 16 and 27 days of absolute drought, the total fall at Inchkeith being only 0·01 in., while Ross-on-Wye, Cranwell and Gorleston with 119 hrs., 99 hrs. and 114 hrs. respectively, established new record durations of sunshine for the month. Temperature was generally above normal in the north but below in the south. On the 1st an intense anticyclone was situated to the west of the British Isles, but small secondaries crossing the country gave north-easterly gales on the east coast of England on the 1st and slight general drizzle (or sleet locally) on the 1st and 2nd, though the weather was mainly fair with some mist or fog. Much sunshine was experienced in the south on the 2nd, when 8·5 hrs. were recorded at Penzance and 8·4 hrs. at Weymouth. This was followed by a night of severe frost, 9°F.

being registered on the ground at Collumpton and 10°F. at Greenwich. On the 3rd much mist or fog, dense in places, persisted locally during the day in England. From the 4th the anticyclone gradually decreased in intensity and the depressions moving from Iceland to Scandinavia came further south until on the 7th the whole country came under the influence of a deep depression centred off south Norway. During this time the weather had been fair to cloudy with much sun in north England and Scotland on the 5th and in England on the 6th. Gales occurred at Lerwick on the 5th. On the 7th there was a change to dull rainy weather with gales generally in the north and Midlands both then and on the 8th, while in the south the conditions were dull with local mist. As this depression moved north-east the anticyclone which was by this time centred over the Bay of Biscay gradually spread north covering the whole country by the 11th and fair sunny conditions were experienced in most areas though mist or fog prevailed generally morning and evening especially in parts of the Midlands and south-east, where occasionally it persisted all day. Owing to fog the maximum at Kew did not rise above 35°F. on the 12th and at Marlborough 36°F. on the 17th. Among the larger amounts of sunshine recorded during this period were 9·0 hrs. at Bognor on the 11th, 8·9 hrs. at Aberystwyth on the 12th and 9·3 hrs. at Jersey on the 14th. A thunderstorm occurred in the Orkneys on the 10th, while pressure reached a record height for February when a value of 1049·7 mb. was registered at Sealand (Chester) on the 15th. From the 19th to 23rd Scotland came under the influence of the depression to the north and moderate to strong westerly winds with cloudy showery weather prevailed while the south was mainly influenced by the anticyclone and had warm sunny days on the 19th-21st but with much persistent mist and fog on the 22nd and 23rd. Ross-on-Wye had 9·7 hrs. bright sunshine on the 21st and Calshot 9·5 hrs. on the 20th. A trough of low pressure crossed the country on the 24th and 25th causing drizzle generally and in the rear of this cold northerly winds, strong at times, swept over the country. Snow occurred locally from the 25th-28th and precipitation was heavy in north England on the 27th, 1·40 in. being recorded at Kildale (Yorkshire), but there were long sunny periods generally. The general distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	44	—14	Liverpool	17	+ 9
Aberdeen	84	+10	Ross-on-Wye	119	+48
Dublin	82	+ 9	Falmouth	105	+22
Birr Castle	68	+ 1	Gorleston	114	+33
Valentia	91	+22	Kew	77	+17

The special message from Brazil states that the rainfall was plentiful in the northern and southern regions with 3·34 in. and 1·85 in. above normal respectively, and scarce in the central regions with 3·11 in. below normal. Three anticyclones passed across the country and temperature was generally high in the south. Cereals, beans and tobacco crops were affected by lack of rain in the first period in the north and south, but conditions were good for the cane and cotton in all regions. At Rio de Janeiro pressure was 0·3 mb. above the normal and temperature 0·4° F. below normal.

Miscellaneous notes on weather abroad culled from various sources. Temperature in Lisbon and north of the Tagus fell below freezing point on the night of the 3rd-4th. Several people were killed as the result of avalanches falling on the mountain villages of Montefortino and Bolognola in the southern part of the Marches near Rome at the beginning of the month, and the snowstorms were followed by heavy rain on the 4th and 5th. Owing to an exceptionally low tide at Venice on the 13th most of the canals inside the city ran dry. Severe easterly gales occurred off the southern coast of Spain about the 14th and south-easterly gales over Madeira on the 17th. Gales were also experienced over southern Norway and Denmark on the 19th and 20th. No snow or rain fell for nearly three weeks in parts of Switzerland early in the month and the sunshine melted much of the snow below the 3,000 ft. level. Some snow, however, fell on the Alps at the end of the month. Severe weather has occurred in Spain throughout most of the winter (*The Times*, February 5th-March 3rd).

A heavy fall of snow occurred in Tetuan (Spanish Morocco) about the 12th (*The Times*, February 13th).

General light to heavy rains fell in Queensland and New South Wales between about the 19th and 23rd (*The Times*, February 24th).

During the first three weeks of the month temperature was generally below normal in the eastern United States and much above normal in the western States, being as much as 27°F. above normal at Havre (Montana) for the week ending the 13th, while precipitation was deficient in the west and variable along the eastern coasts. During the last week temperature was below normal except in the States along the Pacific coast, while precipitation was variable. Intense cold was experienced in eastern Canada and the eastern United States about the 9th, -14°F. was recorded at New York on the 9th, the lowest temperature recorded there since 1868, when records began, but the temperature rose on the 11th. On the 19th and 20th a severe snowstorm occurred throughout the eastern States dislocating all traffic but the 21st was sunny and less cold. Another severe snowstorm occurred on the 25th and 26th. In the south of the States a

series of tornadoes, earlier than usual, caused the death of many persons and did much damage in Mississippi, Louisiana, Alabama and Georgia. The Pacific coast had torrential rains on the 25th. The weather was also very cold and snowy in Canada throughout the month. The fall of 17 in. of rain in 36 hours near Santos, Brazil, about the 20th started landslips which caused 20 deaths (*The Times*, February 10th-28th and *Washington, D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin and Daily Weather Report*).

After many sunny and comparatively mild days the weather turned stormy and bitterly cold in the Bay of Whales, Ross Sea (*The Times*, February 8th).

Daily Readings at Kew Observatory, February, 1934

Date.	Pressure, M.S.L. 13h	Wind, Dir., Force 13h	Temp. Min.	Temp. Max.	Rel. Hum. 13h.	Rain	Sun	REMARKS (see p. 1)
	mb.		°F	°F	%	in.	hrs.	
1	1033·9	NE.5	38	40	42	0·01	4·1	pr$_o$ 2h.-ps$_o$ 12h.
2	1038·4	NE.4	28	36	46	—	4·4	x early. m. 18h.
3	1033·3	WSW.2	24	39	94	0·02	0·0	f 9h.-18h.d.12h.-19h.
4	1030·5	NE.4	38	41	79	trace	0·0	d$_o$ 9h. & 21h.
5	1030·6	NE.4	39	43	74	—	0·0	
6	1028·4	N.2	37	50	66	—	6·4	f 9h. f$_o$ 21h.
7	1026·8	W.3	35	46	68	—	0·3	f$_o$ 18h.
8	1022·3	NW.4	37	49	40	trace	6·6	r$_o$ 9h.
9	1032·0	WSW.4	31	48	55	—	7·6	x early. f$_o$ 9h.
10	1027·6	W.2	35	48	71	trace	0·5	pr$_o$ 17h. f$_o$ 18 h.
11	1036·1	SW.2	34	44	95	trace	3·2	x early. f F all day
12	1041·0	SW.1	29	35	99	trace	0·0	x early F all day
13	1040·5	ESE.2	28	45	78	trace	0·0	F 0h.-12h.f$_o$17h.-22h.
14	1038·8	SSW.1	26	45	96	trace	3·3	x F 0h.-16h.
15	1048·3	E.1	34	46	87	—	0·6	f$_o$-F all day
16	1045·1	WNW.1	30	53	77	trace	5·2	F 0h.-13h. f 18h.
17	1043·5	Calm	35	41	95	trace	0·0	F 0h.-15h.
18	1040·6	S.2	37	39	78	trace	0·0	f$_o$ 9h. f 10h.-12h.
19	1036·6	W.2	30	48	72	—	2·3	x f 7h.-11h. f$_o$ 21h.
20	1036·0	NW.3	31	50	61	—	7·3	f 9h. f$_o$ 18h.
21	1033·1	NW.3	35	50	62	—	4·9	f$_o$ x 18h.-24h.
22	1030·0	W.2	34	49	72	—	6·7	f x 20h.-24h.
23	1027·1	SW.2	30	39	91	trace	0·0	fx0h.-10h.& 20h.-24h.
24	1016·3	S.2	29	44	90	trace	0·4	f x 0h.-13h. r$_o$ 18h.
25	1008·4	SSW.3	43	46	93	0·04	0·0	r$_o$ 2h.-5h.&15h.-17h.
26	1017·3	N.4	36	37	34	trace	4·9	ps$_o$ 7h. 22m.
27	1007·3	NNW.3	28	40	59	—	8·0	ps$_o$ early.
28	1006·0	N.3	36	37	80	0·15	0·0	is to irs 8h.-17h.

General Rainfall for February, 1934

England and Wales ...	22	per cent of the average 1881-1915.
Scotland	42	
Ireland	11	
British Isles	24	

Rainfall: February, 1934: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	·20	12	*Leics.* .	Thornton Reservoir ...	·75	45
Sur .	Reigate, Wray Pk. Rd.	·34	16	,, .	Belvoir Castle............	·52	31
Kent .	Tenterden, Ashenden...	·15	8	*Rut* .	Ridlington	·49	30
,, .	Folkestone, Boro. San .	·19	...	*Lincs* .	Boston, Skirbeck	·52	36
,, .	Eden'bdg., Falconhurst	·12	5	,, .	Cranwell Aerodrome ...	·48	32
,, .	Sevenoaks, Speldhurst	·18	...	,, .	Skegness, Marine Gdns	·76	50
Sus .	Compton, Compton Ho.	·05	2	,, .	Louth, Westgate	1·14	59
,, .	Patching Farm	·00	0	,, .	Brigg, Wrawby St. ...	1·49	...
,, .	Eastbourne, Wil. Sq.	·04	2	*Notts* .	Worksop, Hodsock ...	·94	61
,, .	Heathfield, Barklye ...	·24	10	*Derby* .	Derby, L. M. & S. Rly.	·41	25
Hants .	Ventnor, Roy. Nat. Hos.	·04	2	,, .	Buxton, Terr. Slopes	·32	9
,, .	Fordingbridge, Oaklnds	·04	2	*Ches* .	Runcorn, Weston Pt...	·34	18
,, .	Ovington Rectory	·14	5	*Lancs* .	Manchester, Whit. Pk.	·32	17
,, .	Sherborne St. John ...	·06	3	,, .	Stonyhurst College ...	·31	9
Herts .	Welwyn Garden City...	·46	28	,, .	Southport, Hesketh Pk	·09	4
Bucks .	Slough, Upton	·13	8	,, .	Lancaster, Greg Obsy.	·15	5
,, .	H. Wycombe, Flackwell	·13	7	*Yorks* .	Wath-upon-Dearne ...	·55	33
Oxf .	Oxford, Mag. College...	·24	15	,, .	Wakefield, Clarence Pk.	·34	20
Nor .	Pitsford, Sedgebrook...	·46	28	,, .	Oughtershaw Hall......	·43	...
,, .	Oundle.....................	·42	...	,, .	Wetherby, Ribston H.	·65	38
Beds .	Woburn, Exptl. Farm..	·39	26	,, .	Hull, Pearson Park ...	1·81	109
Cam .	Cambridge, Bot. Gdns.	·29	23	,, .	Holme-on-Spalding ...	1·01	60
Essex .	Chelmsford, County Lab	·19	13	,, .	West Witton, Ivy Ho.	·11	4
,, .	Lexden Hill House ...	·24	...	,, .	Felixkirk, Mt. St. John	1·42	84
Suff .	Haughley House.........	·27	...	,, .	York, Museum Gdns.	1·68	111
,, .	Campsea Ashe............	·38	28	,, .	Pickering, Hungate ...	1·86	107
,, .	Lowestoft Sec. School	·41	29	,, .	Scarborough	1·87	111
,, .	Bury St. Ed. Westley H.	·31	21	,, .	Middlesbrough	·75	58
Norf .	Wells, Holkham Hall	·72	49	,, .	Baldersdale, Hury Res.	...	...
Wilts .	Calne, Castleway	·12	6	*Durh* .	Ushaw College	·43	27
,, .	Porton, W. D. Exp'l. Stn	·06	3	*Nor* .	Newcastle, Town Moor	·43	27
Dor .	Evershot, Melbury Ho.	·17	5	,, .	Bellingham, Highgreen	·15	6
,, .	Weymouth, Westham .	·03	1	,, .	Lilburn Tower Gdns...	·53	27
,, .	Shaftesbury, Abbey Ho.	·08	3	*Cumb* .	Carlisle, Scaleby Hall	·16	7
Devon .	Plymouth, The Hoe ...	·11	4	,, .	Borrowdale, Seathwaite	2·50	22
,, .	Holne, Church Pk. Cott.	·33	6	,, .	Borrowdale, Moraine...	1·01	11
,, .	Teignmouth, Den Gdns.	·18	7	,, .	Keswick, High Hill...	·22	4
,, .	Cullompton...............	·41	15	*West* .	Appleby, Castle Bank	·18	6
,, .	Sidmouth, Sidmount...	·13	5	*Mon* .	Abergavenny, Larchf'd	·29	9
,, .	Barnstaple, N. Dev. Ath	·36	13	*Glam* .	Ystalyfera, Wern Ho.	·77	15
,, .	Dartm'r, Cranmere Pool	·50	...	,, .	Cardiff, Ely P. Stn. ...	·59	20
,, .	Okehampton, Uplands	·28	6	,, .	Treherbert, Tynywaun	·94	...
Corn .	Redruth, Trewirgie ...	·35	9	*Carm* .	Carmarthen, Priory St.	·67	18
,, .	Penzance, Morrab Gdn.	·21	6	*Pemb* .	Haverfordwest, School	·53	15
,, .	St. Austell, Trevarna...	·32	8	*Card* .	Aberystwyth	·50	...
Soms .	Chewton Mendip	·45	13	*Rad* .	Birm W. W. Tyrmynydd	·44	8
,, .	Long Ashton	·41	17	*Mont* .	Lake Vyrnwy...........	·38	8
,, .	Street, Millfield.........	·20	10	*Flint* .	Sealand Aerodrome ...	·16	10
Glos .	Blockley	·53	...	*Mer* .	Dolgelley, Bontddu ...	·81	18
,, .	Cirencester, Gwynfa ...	·28	12	*Carn* .	Llandudno	·27	14
Here .	Ross, Birchlea............	·39	19	,, .	Snowdon, L. Llydaw 9	1·81	...
Salop .	Church Stretton.........	·33	15	*Ang* .	Holyhead, Salt Island	·26	11
,, .	Shifnal, Hatton Grange	·31	19	,, .	Lligwy.....................	·35	...
Staffs .	Market Drayt'n, Old Sp.	·42	24	*Isle of Man*			
Worc .	Ombersley, Holt Lock	·41	25		Douglas, Boro' Cem. ...	·25	8
War .	Alcester, Ragley Hall..	·44	27	*Guernsey*			
,, .	Birminghm. Edgbaston	·29	17		St. Peter P't. Grange Rd	·09	4

Rainfall: February, 1934: Scotland and Ireland.

Co.	Station	In.	Per cent. of Av.	Co.	Station	In.	Per cent. of Av.
Wig	Pt. William, Monreith	·44	14	*Suth*	Melvich	2·82	94
,,	New Luce School	·72	19	,,	Loch More, Achfary	9·20	139
Kirk	Dalry, Glendarroch	·58	11	*Caith*	Wick	1·66	73
,,	Carsphairn, Shiel	1·15	17	*Ork*	Deerness	3·82	127
Dumf	Dumfries, Crichton, R.I	·28	9	*Shet*	Lerwick	3·33	105
,,	Eskdalemuir Obs.	·41	8	*Cork*	Caheragh Rectory	·38	...
Roxb	Branxholm	·20	8	,,	Dunmanway Rectory	·25	4
Selk	Ettrick Manse	·40	9	,,	Cork, University Coll.	·32	9
Peeb	West Linton	·37	...	,,	Ballinacurra	·34	9
Berw	Marchmont House	·19	9	*Kerry*	Valentia Obsy.	·74	14
E. Lot	North Berwick Res.	·04	3	,,	Gearhameen	·70	8
Midl	Edinburgh, Roy. Obs.	·09	5	,,	Darrynane Abbey	1·00	22
Lan	Auchtyfardle	·38	...	*Wat*	Waterford, Gortmore	·29	9
Ayr	Kilmarnock, Kay Pk.	·63	...	*Tip*	Nenagh, Cas. Lough	·39	13
,,	Girvan, Pinmore	·84	20	,,	Roscrea, Timoney Park	·20	...
Renf	Glasgow, Queen's Pk.	·52	18	,,	Cashel, Ballinamona	·27	8
,,	Greenock, Prospect H.	·92	16	*Lim*	Foynes, Coolnanes	·30	9
Bute	Rothesay, Ardencraig.	1·41	...	,,	Castleconnel Rec.	·19	...
,,	Dougarie Lodge	·64	...	*Clare*	Inagh, Mount Callan	·73	...
Arg	Ardgour House	4·16	...	,,	Broadford, Hurdlest'n.	·26	...
,,	Glen Etive	5·00	58	*Wexf*	Gorey, Courtown Ho.	·44	16
,,	Oban	1·40	...	*Wick*	Rathnew, Clonmannon	·05	...
,,	Poltalloch	1·47	35	*Carl*	Hacketstown Rectory	·12	4
,,	Inveraray Castle	3·18	47	*Leix*	Blandsfort House	·17	6
,,	Islay, Eallabus	·84	20	,,	Mountmellick	·14	...
,,	Mull, Benmore	...	...	*Offaly*	Birr Castle	·17	7
,,	Tiree	·69	20	*Dublin*	Dublin, FitzWm. Sq.	·03	2
Kinr	Loch Leven Sluice	·09	3	,,	Balbriggan, Ardgillan.	·09	5
Perth	Loch Dhu	1·70	23	*Meath*	Beaupare, St. Cloud	·11	...
,,	Balquhidder, Stronvar	·55	...	,,	Kells, Headfort	·11	4
,,	Crieff, Strathearn Hyd.	·17	5	*W. M*	Moate, Coolatore	·23	...
,,	Blair Castle Gardens	·53	19	,,	Mullingar, Belvedere	·19	7
Angus	Kettins School	·08	3	*Long*	Castle Forbes Gdns.	·29	10
,,	Pearsie House	·26	...	*Gal*	Galway, Grammar Sch.	·26	...
,,	Montrose, Sunnyside	·16	9	,,	Ballynahinch Castle	·56	11
Aber	Braemar, Bank	·44	15	,,	Ahascragh, Clonbrock.	·18	6
,,	Logie Coldstone Sch.	·40	19	*Mayo*	Blacksod Point	1·00	25
,,	Aberdeen, King's Coll.	·65	32	,,	Mallaranny	1·25	...
,,	Fyvie Castle	1·62	72	,,	Westport House	·92	23
Moray	Gordon Castle	1·29	67	,,	Delphi Lodge	1·66	20
,,	Grantown-on-Spey	·93	44	*Sligo*	Markree Obsy.	·63	18
Nairn	Nairn	·54	30	*Cavan*	Crossdoney, Kevit Cas.	·23	...
Inv's	Ben Alder Lodge	1·90	...	*Ferm*	Enniskillen, Portora	·30	...
,,	Kingussie, The Birches	·72	...	*Arm*	Armagh Obsy.	·27	12
,,	Inverness, Culduthel R.	·31	...	*Down*	Fofanny Reservoir	·15	...
,,	Loch Quoich, Loan	11·20	...	,,	Seaforde	·07	2
,,	Glenquoich	6·60	64	,,	Donaghadee, C. Stn.	·19	8
,,	Arisaig, Faire-na-Sguir	1·94	...	,,	Banbridge, Milltown	·13	6
,,	Fort William, Glasdrum	2·75	...	*Antr*	Belfast, Cavehill Rd.	·46	...
,,	Skye, Dunvegan	2·25	...	,,	Aldergrove Aerodrome	·29	12
,,	Barra, Skallary	1·48	...	,,	Ballymena, Harryville	·61	19
R & C	Alness, Ardross Castle	2·07	63	*Lon*	Garvagh, Moneydig	·57	...
,,	Ullapool	3·04	71	,,	Londonderry, Creggan	·98	31
,,	Achnashellach	6·32	87	*Tyr*	Omagh, Edenfel	·53	18
,,	Stornoway	2·59	58	*Don*	Malin Head	·39	...
Suth	Lairg	3·46	112	,,	Milford, The Manse	·76	23
,,	Tongue	3·00	86	,,	Killybegs, Rockmount.	·59	...

Errata: Loch Leven Sluice, January, for 3·48 \| 110 read 3·67 \| 116.

Climatological Table for the British Empire, September, 1933

STATIONS	PRESSURE: Mean of Day M.S.L. (mb.)	PRESSURE: Diff. from Normal (mb.)	TEMPERATURE: Absolute Max. (° F.)	Absolute Min. (° F.)	Mean Values Max. (° F.)	Mean Values Min. (° F.)	Mean Values ½ max. and min. (° F.)	Mean Values Diff. from Normal (° F)	Mean Wet Bulb (° F.)	Relative Humidity (%)	Mean Cloud Am'nt (0—10)	PRECIPITATION: Am'nt (in.)	Diff. from Normal (in.)	Days	BRIGHT SUNSHINE: Hours per day	Percentage of possible
London, Kew Obsy.	1017·5	+ 0·1	79	42	68·9	53·8	61·3	+ 4·2	54·5	89	6·3	2·72	+ 0·85	12	6·3	50
Gibraltar	1015·6	— 1·6	86	56	79·8	65·2	72·5	+ 0·1	66·1	79	3·3	0·00	— 1·31	0	..	..
Malta	1017·9	+ 1·6	86	65	79·8	69·1	74·5	— 1·5	68·1	71	2·5	0·08	— 1·19	2	10·5	85
St. Helena	1015·2	— 0·3	62	53	59·4	54·0	56·7	— 0·7	54·8	95	9·8	1·11	..	16	..	..
Freetown, Sierra Leone	1014·7	+ 2·5	86	63	83·4	67·2	75·3	— 3·8	75·2	89	6·7	15·63	— 12·85	25	..	..
Lagos, Nigeria	1013·6	+ 1·4	87	69	83·0	74·1	78·5	— 0·2	74·4	88	9·4	5·49	— 0·10	12	4·1	34
Kaduna, Nigeria	1013·2	— 1·1	88	65	84·7	67·6	76·1	+ 0·8	71·1	87	7·7	10·94	— 0·56	21	6·1	50
Zomba, Nyasaland	1014·6	+ 0·9	90	50	78·0	57·6	67·8	— 1·7	57·9	49	4·2	0·21	— 0·13	3	..	..
Salisbury, Rhodesia	1016·4	+ 0·1	85	42	77·1	50·3	63·7	— 2·7	52·7	45	1·5	0·22	— 0·06	2	9·0	75
Cape Town	1021·0	+ 1·9	81	38	67·2	50·9	59·1	+ 1·2	52·0	79	4·9	1·22	— 1·02	9	..	..
Johannesburg	1017·3	+ 1·1	80	37	72·4	47·6	60·0	+ 0·6	47·8	47	1·7	0·38	— 0·58	1	10·0	84
Mauritius	1021·0	+ 0·8	79	56	74·7	62·6	68·6	— 1·5	63·3	67	7·1	1·79	+ 0·49	19	6·6	55
Calcutta, Alipore Obsy.	1004·4	— 0·1	93	76	88·4	78·4	83·4	+ 0·2	78·9	89	6·9	10·49	+ 0·48	16*	..	..
Bombay	1005·9	— 2·1	90	74	86·0	76·3	81·1	+ 0·2	76·4	86	6·2	12·31	+ 1·63	13*	..	..
Madras	1006·0	— 0·5	99	75	93·6	78·5	86·1	+ 0·9	76·0	70	7·6	1·20	— 3·65	5*	..	..
Colombo, Ceylon	1010·3	+ 0·4	84	73	83·2	76·5	79·9	— 1·3	76·3	81	7·5	4·13	— 0·63	19	5·8	48
Singapore	1009·4	— 0·4	92	69	87·0	73·8	80·4	— 0·7	76·6	80	6·6	6·03	— 0·76	18	5·9	49
Hongkong	1008·0	— 0·3	92	74	87·1	78·3	82·7	+ 1·7	76·7	76	6·0	12·58	+ 2·89	18	6·5	53
Sandakan	1009·5	..	92	72	88·4	74·5	81·5	— 0·2	76·7	82	7·6	10·81	+ 1·48	21	..	..
Sydney, N.S.W.	1017·9	+ 1·8	80	42	65·9	51·9	58·9	— 0·3	53·2	67	5·6	2·78	— 0·08	16	6·6	55
Melbourne	1017·9	+ 2·1	71	34	61·5	45·2	53·3	— 0·8	49·9	69	5·9	1·20	— 1·24	13	4·7	40
Adelaide	1018·6	+ 1·1	75	39	64·9	47·7	56·3	— 0·8	50·8	59	6·6	2·89	+ 0·84	16	5·4	46
Perth, W. Australia	1018·6	+ 0·6	87	44	68·6	50·4	59·5	+ 1·3	53·6	60	4·1	2·62	— 0·80	10	7·9	66
Coolgardie	1018·4	+ 1·3	89	38	70·8	45·7	58·3	— 0·4	51·6	56	3·3	0·38	— 0·29	5	..	..
Brisbane	1018·6	+ 1·0	80	45	72·9	56·2	64·5	— 0·7	58·9	64	5·6	4·27	+ 2·27	9	6·7	57
Hobart, Tasmania	1013·4	+ 2·4	69	37	59·8	44·8	52·3	+ 1·3	47·2	64	6·5	1·65	— 0·42	12	5·6	47
Wellington, N.Z.	1018·2	+ 3·6	65	37	56·1	45·1	50·6	— 1·0	47·6	74	6·2	2·97	— 1·00	14	6·4	54
Suva, Fiji	1015·5	+ 1·2	88	65	81·5	70·8	76·1	+ 1·6	70·7	76	7·6	1·53	— 6·16	19	4·8	40
Apia, Samoa	1012·5	+ 0·3	87	69	84·6	73·2	78·9	+ 0·7	75·9	76	5·5	10·70	+ 5·59	19	7·2	60
Kingston, Jamaica	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grenada, W.I.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Toronto	1012·8	— 5·0	90	39	71·8	53·7	62·7	+ 2·4	57·0	82	5·9	1·35	— 1·32	14	6·5	52
Winnipeg	1008·9	— 4·9	79	32	66·0	47·1	56·5	+ 2·8	47·5	89	4·5	2·69	+ 0·47	10	6·1	48
St. John, N.B.	1011·9	— 5·5	72	40	63·9	49·9	56·9	+ 1·0	52·9	85	7·2	5·44	+ 1·70	16	4·7	37
Victoria, B.C.	1012·0	— 4·4	68	40	60·2	48·3	54·3	— 1·8	51·6	89	7·1	2·86	+ 1·05	19	5·7	45

*For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

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